

DEEP C METER 3000 AD™ ROV-MOUNTED CP PROBE OPERATION MANUAL



ROV-interfaced
cathodic protection
monitoring system

Can output both
contact and EFG
probe readings

Digital output
RS232 standard
ASCII string

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1. Overview

The Deep C Meter 3000 AD™ is a complete ROV-interfaced cathodic protection monitoring system.

The system comprises five basic parts:

1.1 LED readout

Triple voltmeters housed in a stainless steel pressure housing.

1.2 Contact probe

Twin element, tip contact CP probe (Polatrak® Model ROV-II™).

1.3 Flying lead

Three-meter-long umbilical that connects the probe to the readout.

1.4 Power whip

Two-meter-long umbilical that interfaces with the ROV for power and data output.

1.5 EFG probe (optional)

Can be added as an upgrade to the standard package.

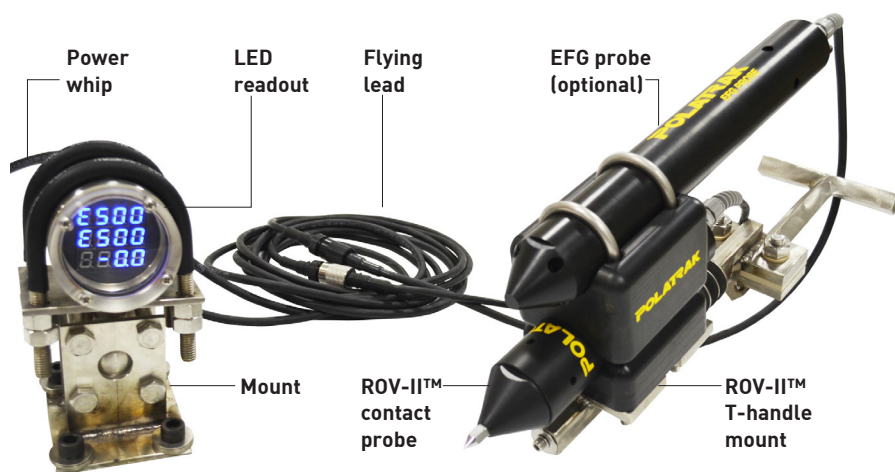


Figure 1: Deep C Meter 3000 AD™ components

1.6 The Deep C Meter 3000 AD™ has the following upgrades from previous versions:

- Smaller pressure housing
- Combines ROV-II™ and Polatrak EFG pressure housing
- Programmable ultra-bright LED displays with brightness adjustments
- Digital output (RS232 – standard ASCII string)
- ROV 24V DC powered, which eliminates the need to open the pressure housing to change batteries

2. Reference documents

Please see the following pages for pertinent MSDS documents; Polatrak® manuals are available at <https://stoprust.com/resources/downloads/>

2.1 ROV-II Operations Manual (354-MN01-ENG)

2.2 EFG 1 Operations Manual (358-MN02-ENG)

2.3 RUSS Operation Manual (358-MN04-ENG)

2.4 Parker Seals - Parker O Lube MSDS – O-ring lubricant
<https://www.parker.com/literature/O-Ring%20Division%20Literature/SDS%20O-lube.pdf>

2.5 Dow Corning – 4 Electrical Insulating Compound MSDS – connector sealant

<https://3eonline.com/ImageServer/ImageViewer.aspx?id=Ri81UOMdRxGgoF4FuEjOkN0P3wEfJ3v7z4erMLZ0sppEvgQ6PDo5m1aHMuQjBlHhdsvNZb983T3iNcJosE42sHXQec8cyVyFu525heZiq3Y%3d>

PLEASE CONTACT YOUR DEEPWATER REPRESENTATIVE FOR ANY QUESTIONS AND/OR ISSUES REGARDING THIS MANUAL.

3. Health and safety

It is the intention of Deepwater Corrosion Services that all procedures will be carried out in a safe manner in accordance with the Health and Safety At Work Act and any other relevant legislation. If required by the client, Deepwater personnel will attend any site safety induction courses before carrying out work on site.

4. LED readout components

The readout unit has three major sub-assemblies: The pressure housing, articulated mount and flying leads.

4.1. Deep C Meter 3000 AD™

4.1.1. Pressure housing - The pressure housing is made from 316 stainless steel and is rated for water depths of 3,000 meters (10,000 feet).

4.1.2. Lens - One end of the housing contains an acrylic lens that seals on the pressure housing with o-rings. Four stainless-steel screws keep the lens seated in the pressure housing. Access to the inside of the pressure housing is gained by pulling the lens. Removing the lens in the field should be avoided whenever possible.

4.1.3. Bulkhead connector - The back end of the pressure housing is sealed with three bulkhead connectors. These connectors thread into the back of the pressure housing and also seal with o-rings. It should not be necessary to remove these connectors during normal maintenance. Blank (dummy) plugs are provided and should be in place whenever the mating connector is removed.

4.1.4. Voltmeter module - The digital voltmeter module is located within the pressure housing. The module contains three independent LED displays. Default factory range is ± 2499 mV DC



Figure 2: Front of pressure housing

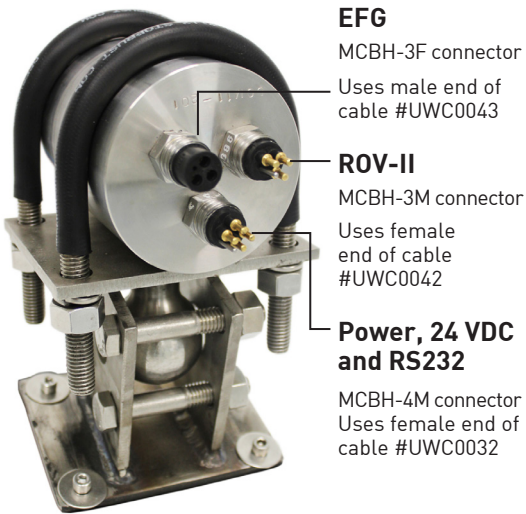


Figure 3: Rear of pressure housing

on the top two display lines. The lower display line is set to $\pm 199.9\text{mV DC}$. The meter is powered by 24VDC nominal power but will function between 8-36VDC.

4.2. Articulating mount

4.2.1. The articulating mount is designed to secure the Deep C Meter 3000 AD™ to the ROV frame and provide angled adjustment to optimize camera viewing of the displays. The mount and all fixing hardware are made of 316 stainless steel.



Figure 4: Meter mount (UWC0001)

4.3. Flying leads

4.3.1. There are three leads supplied per kit, each serving a unique function.

4.3.2. A full wiring diagram can be found in section 6.0.

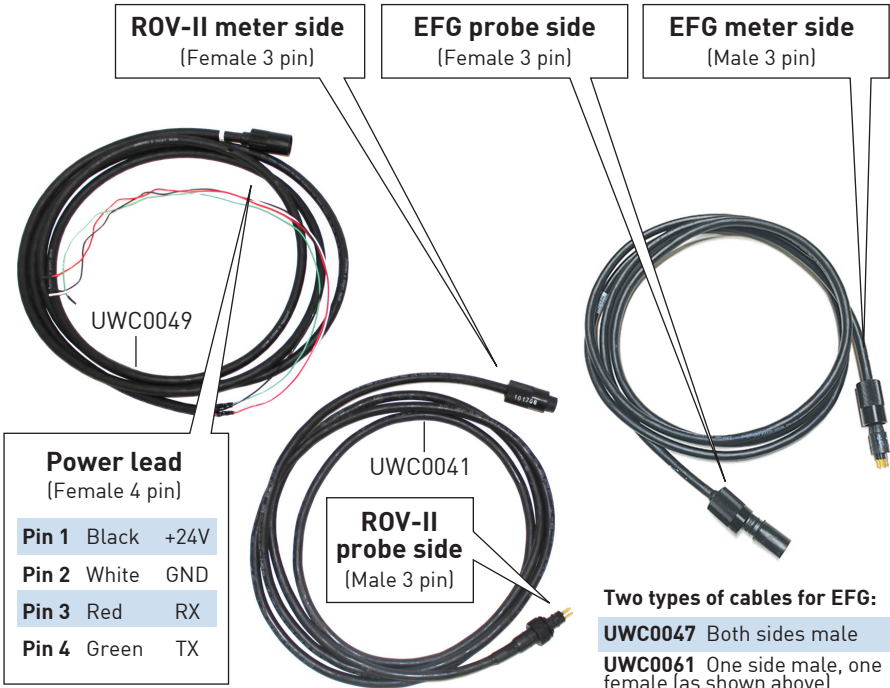


Figure 5: Flying leads

5. Probe unit components

The Deep C Meter 3000 AD™ utilizes the popular Polatrak ROV-II™ tip contact probe. More detailed information can be found in the ROV-II™ operation manual Doc. No. 354-MN01-ENG.

5.1. Housing - The housing provides protection to the reference electrode elements. It is made from a rugged thermoplastic and is designed to fit the compliant tee handle mount for convenient manipulator mounting. The holes in the side allow the body to become free-flooding and are specifically engineered to allow for accurate potential measurements.

CAUTION

Do not cover or modify the existing holes or add additional holes in the body.

5.2 Tail assembly - The tail assembly attaches to the main body section with two (2) stainless steel ¼”-20 allen head cap screws. The ROV-II flying lead passes through this unit and has a spiral strain relief fitting. The tail unit includes one male connector for the contact tip and two female connectors for each of the reference electrodes.

5.3 Nose cone w/ tip - The nose cone assembly is screwed into the main body section. The cone houses the replaceable contact tip; it also includes the female connector that attaches to the male pin on the extension cable from the tail unit. Tips are made from stainless steel and plated with nickel; the nose cone is fabricated from a rugged thermoplastic.

5.4 Reference electrode element - Two plug-in silver/silver chloride elements are included.

Electrode elements are accurate to ± 5 mV. See the operations and maintenance section for instructions on electrode replacement.

CAUTION

Never handle electrode elements with bare hands or expose elements to a liquid other than fresh water or seawater, as permanent damage may result.

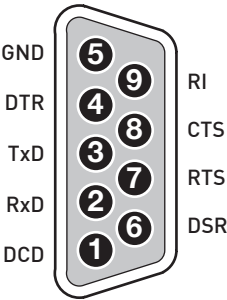
6. ROV Interface

Table 1: ROV interface pin outs

RS232 cable (serial)

DB9 female connector pin out

Pin	Polarity	Cable color
2	RX 232	Red
3	TX 232	White
5	Signal GND	Black



Pin

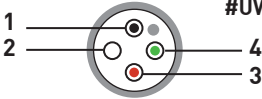
- 1. Data carrier detect
- 2. Receive data
- 3. Transmit data
- 4. Data terminal ready
- 5. Signal ground
- 6. Data set ready
- 7. Request to send
- 8. Clear to send
- 9. Ring indicator

Table 1: ROV interface pin outs (continued)

4-pin bulkhead - MCBH-4M

(MCIL-4F male connector)

Uses female Polatrak cable #UWC0032



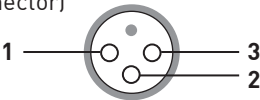
Pin	Polarity	Wire color
1	+24 Power VDC	Black
2	Pwr/Signal GND	White
3	RX 232	Red
4	TX 232	Green

Table 2: CP equipment pin outs

ROVII - MCBH-3M (Male bulkhead)

(MCIL-3F connector)

Uses female Polatrak cable #UWC0042

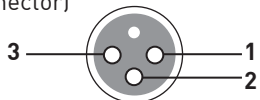


Pin	Polarity	Meter	Wire color
1	Tip		White
2	Element 1	Top	Black
3	Element 2	Middle	Green

EFG - MCBH-3F (Female bulkhead)

(MCIL-3M connector)

Uses male Polatrak cable #UWC0043



Pin	Polarity	Meter	Wire color
1	N/A		White
2	Element 1	Bottom	Black
3	Element 2	Bottom	Green

7. Calibration tests

With all the parts connected, the probe(s) should be tested in a non-metallic bucket as described in section 7.2 to verify that all components are within calibration prior to deploying the ROV.

7.1. Deep C Meter 3000 AD™ calibration

7.1.1 Power-on the unit and allow approximately 5-10 seconds for the automatic boot-up calibration process to complete.

7.1.2 Apply a known potential between 0.100V - 2.000V (battery or portable power supply). Measure the potential directly with a multimeter.

7.1.3 Measure the potential reading with the Deep C Meter 3000 AD™. These two potentials should be within ± 5 mV. If the difference is greater, send the calibration command through the RS232 interface. Please see section 12.2 for further details.

7.2. Bucket calibration check (Please see figure 7 on page 23)

Contact calibration check

7.2.1 Fill a clean, non-metallic bucket or container with seawater approximately 16 –18 inches deep. Ensure that the bucket has been completely degreased and rinsed.

7.2.2 Place the probe in the bucket with the tip at an angle to fill the body with seawater. The entire probe, including the tip, must be immersed. Ensure there is no trapped air in the unit.

7.2.3 Attach or stab the zinc coupon firmly onto the probe tip. The upper two display lines on the LED readout should read between (-) 1.030V and (-) 1.070V and be within 0.005V of each other.

NOTE: If the probe has not been used in the past 24 hours, it may take 15-30 minutes for the probe to reach equilibrium.

EFG™ calibration check (only applicable if using the EFG™ probe)

7.2.4 Ensure both sets of holes on the EFG™ probe are submerged. Ensure there is no trapped air in the probe. If the bucket is too short, remove the tail assembly and place the electrode directly in the water.

7.2.5 The bottom display line should be less than ± 2 mV. If not, one of the electrodes may need replacing.

7.2.6 Activate the zinc coupon by removing a small section of oxide film with a file or rasp.

7.2.7 Place the zinc coupon directly in front of the probe.

7.2.8 The bottom display line should become more negative.

7.2.9 Remove the zinc coupon. The bottom display line should return to the original value in step 7.2.5.

7.3. Subsea calibrations

7.3.1 While approximately 30 feet away from surrounding structures / assets, stab the isolated zinc ROV calibration coupon with the probe's contact tip.

7.3.2 The upper two display lines on the readout should read between (-) 1.030V & (-) 1.070V and be within 0.010V of each other. Make note of this difference for future readings.

7.3.3 If the EFG™ probe is connected, the bottom display line should go more negative as the probe approaches the coupon and become more positive as the EFG™ probe moves away. If the EFG™ probe is not connected, the bottom display line should be disregarded.

7.3.4 It is recommended that this test be performed at the beginning and end of each dive, every two hours or at a pre-determined calibration period.

7.4. Online subsea check

7.4.1 While free-flying, the top and middle display lines are reading the potential of the stainless contact tip. This number will vary depending on ROV speed, time of immersion and whether a protected structure has been recently stabbed. Normally, the reading will be in the (-) 0.200V to (-) 0.400V range. However, both meters should be within 0.010V of each other. This number should not be more negative than (-) 8.800V.

NOTE: If instrument fails calibration check, go to troubleshooting section 13 in this manual.

8. Operation

8.1 Mounting on ROV

8.1.1 Create the power lead from the 4 pin open-ended cable whip and splice on the required connector to interface with the ROV MUX bottle. See section 6.0 for the correct pin outs.

8.1.2 Verify the whip has power and perform a loop-back test before attaching the unit directly to ensure the data stream is not corrupted. See Table 6 if communication cannot be established.

8.1.3 Find a good location on the vehicle to mount the Deep C Meter 3000 AD™ and attach the articulated mount. Typically, the display unit should be in view at the same time as the probe unit to maximize efficiency. Alternatively, a second camera can be dedicated to the display unit. The LED readout must be visible by the camera; also, having a light source directed at the lens for optimal visibility is recommended.

8.1.4 If using zoom cameras, position the camera approximately

12" away from the edge of the lens.

8.1.5 If using fixed-zoom cameras, physically position the camera approximately 0.5" to 3" away from the edge of the lens.

8.1.6 Ensure that all fasteners are tightly secured and in good condition. Verify that all lock nuts and washers are in place on the readout unit mount.

8.1.7 Connect and route the power lead.

8.1.8 Insert the probe unit into the T-handle and position in a manipulator or tool basket that is manipulator accessible.

8.1.9 If the EFG™ probe has been purchased, the unit can be piggy-backed onto the ROV-II™ probe using the supplied brackets.

8.1.10 Tying a safety lanyard to the T-handle is recommended.

8.1.11 Ensure that lock rings for the flying lead(s) connectors are properly mounted and secured.

8.1.12 Ensure that all fasteners are tight and the lock nuts are in place on the T-handle.

8.1.13 Route the flying lead(s) in such a way that they will not be stressed, entangled or pinched during manipulator operation.

8.1.14 Using the provided connector sealant, apply a small amount to the shoulder of each flying lead(s) connector, ensuring that no sealant is applied to the copper pin. Connect the flying lead to the probe lead and tighten the connector lock ring. Please refer to the MSDS in the appendix before handling sealant. All appropriate Personal Protective Equipment (PPE) shall be worn including safety glasses and gloves as a minimum precaution.

8.1.15 Mount a zinc ROV calibration coupon on the ROV's front porch or manipulator in an area the contact tip can easily reach during subsea calibrations.

8.1.16 Ensure the calibration coupon is electrically isolated from the ROV (Over 1MΩ).

8.1.17 Remove the lens cover from the instrument.

8.1.18 Perform a bucket calibration (see section 7.2).

8.1.19 Using a 7/16" (or 10mm) wrench, ensure that the contact tip is tight on the nose cone.

8.1.20 Ensure that the tip is sharp.

9. Taking CP potential readings

9.1. Stab the contact probe onto the point on the structure where the reading is required; when a good contact is made, the Deep C Meter 3000 AD™ will show a steady reading.

CAUTIONS

- **Avoid stabbing painted or coated surfaces; whenever possible, try to take readings on bare steel or on spots specially designated for CP measurement. CP stab points are typically labeled with "CP".**
- **Anodes can be stabbed if necessary; however, it is always best to stab the anode band where possible, as it is typically grounded to the structure.**
- **Avoid trying to stab through heavy, hard marine growth if possible.**
- **The probe unit should be kept out of the mud to prevent contamination of the electrodes.**
- **If the readings are not steady or do not match the criteria in Table 3, the most likely cause is a high-resistance contact. DO NOT RECORD THESE NUMBERS. Continue to stab until readings stabilize and follow the recommended action. See troubleshooting section 13 if problems persist.**
- **NEVER immerse the system with any connectors un-mated unless the dummy plugs are installed.**

10. Data interpretation

10.1 For carbon steel structures in seawater, the readings obtained should be within the ranges specified in Table 3. Exceptions may occur if the probe is stabbed onto an isolated section of a corrosion-resistant alloy such as stainless steel, copper or nickel. In these cases, Table 3 no longer applies and readings less negative than indicated in the table may be noted. If this is the case, ensure that the readings

are steady and the electrodes maintain the same potential difference between each other during the last calibration check.

Table 3 - Normal cathodic protection ranges for bare carbon steel in seawater

Range (mV)	Interpretation	Action
-500 or more positive	Error (unless unprotected)	Remake contact & verify Measure two other points around the component
-501 to -649	Isolated from cathodic protection	Remake contact & verify Record data
-650 to -799	Not cathodically protected	
-800 to -849	Marginal cathodic protection	
-850 to -1049	Cathodically protected	Record data
-1050 to -1149	Anode potential	
-1150 or more negative	Error	Remake contact & verify Measure two other points around the component

Note: For brackish or fresh water, please consult Peterson’s Nomogram.

10.2 Removal from ROV

10.2.1 When equipment is removed from the ROV, wash thoroughly with fresh water and allow to dry. Soak the ROV-II™ and EFG™ probe units in fresh water for at least one hour. Replace lens cover on Deep C Meter 3000 AD™ and place it in the protective case provided.

11. Maintenance and repair

This section covers general operational maintenance; attempting any tasks not described in this section may result in damage to the system.

11.1 Tip replacement

11.1.1 From time to time, it will be necessary to replace the contact tip. Remove the old tip with a 7/16" or 10mm wrench. Ensure that the new tip is tight, but do not over-tighten. (Max torque 50 in-lbs)

11.2 Electrode element replacement

11.2.1 Remove the probe from the ROV and un-mate the connector. Install the dummy plug provided onto the exposed flying lead connector.

11.2.2 Fill a clean, non-metallic bucket or container with sea-water filled approximately 16 –18 inches deep. Ensure that the bucket has been completely degreased and rinsed.

11.2.3 Put the probe into the bucket and stab or attach the zinc to the contact tip.

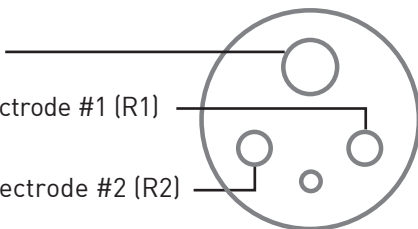
11.2.4 The contact probe connector is a SEA CON® RMG-3FS and is wired as shown below.

Figure 6: SEA CON® RMG-3FS female socket connector pin diagram

Pin socket 1: Contact tip

Pin socket 2: Reference electrode #1 (R1)

Pin socket 3: Reference electrode #2 (R2)



11.2.5 Using a digital voltmeter set on 2.00 VDC range, stab the large pin socket (pin 1) with the positive voltmeter lead and stab pin socket 2 (first clockwise of large pin) with the negative lead (note reading). Then repeat stabbing pin socket 3 with the negative lead and note the reading. The faulty electrode will be the one that gives the lowest (least negative) reading.

11.2.6 Ensure that the probe is drained of seawater.

11.2.7 Take probe unit to a clean area. Do not handle the small electrode pellets with bare hands.

11.2.8 Remove the two screws that secure the tail unit and gently pull out the tail unit to expose the electrode elements. Try to avoid un-mating the tip connector.

11.2.9 Visually inspect to ensure that the wire is not damaged and the connector is properly mated.

11.2.10 Remove the bad electrode and discard.

11.2.11 Take the new electrode and carefully place a small amount of silicone grease on the pin and sealing section of the connector. Plug the new electrode into the connector.

11.2.12 Check that all connectors are fully mated and carefully put the electrodes back into the housing and re-attach the tail unit and nose cone.

11.2.13 Repeat the calibration check as described above. Allow the probe to soak. (Note: A new dry element may take up to 30 minutes to reach equilibrium)

CAUTION:

Never immerse the connector pin of an electrode element in water.

12. RS232 Functions

12.1 Data output

12.1.1 Data string structure: Stab 1, Stab 2, EFG

For example:

-1034, -1035, -12.2

-1034, -1036, 12.2

12.1.2 After each data set there is a line feed and carriage return present. The rate is 2 data sets per second.

Table 4: RS232 communication settings

Speed (Baud) :	9600
Data bits:	8
Stop bits:	1
Parity:	None
Flow control:	None

12.2 Control data input

The following functions can be accessed by sending commands over the RS232 interface from within RUSS or through a standard serial program.

(See table 5 on following page)

Table 5: RS232 command list

Action	Input command	Modifier	Response	Result	Example
LED intensity	SI←intensity→! Where intensity is a hex number between 0 and F	Sets the intensity of the LED display. The brightness is set according to the hexadecimal value placed in the intensity value location.	There is no response for this protocol	The display will change intensity in real time with no effect on the streaming data.	Lowest intensity Command: SI0! Half intensity Command: SI8! Full intensity Command: SIF!
Data stream delimiter	SD←delimiter→!	Sets the output delimiter in the data stream to the user's preference. Separate with commas or tabs: (-1020, -1020, 0.1) (-1020 -1020 0.1)	There is no response for this protocol	The delimiter character in the data stream will change to the Comma or Tab character in real time.	Comma separator Command: SD,! Tab separator Command: SDHT!
Analog polarity command	SP←polarity→!	Sets the polarity of analog voltages being measured by the ADC.	There is no response for this protocol	Positive character sets the common analog ground to the negative side of the converter.	Positive Command: SP+! Negative Command: SP-!
Online calibration	Cal!	Re-calibrates the internal AD, which takes approximately 20 seconds	There is no response for this protocol.	The data stream will be interrupted during the calibration process.	Command: Cal!

NOTE: Do not include brackets ←→ when inputting commands.

13. Troubleshooting

13.1 General

13.1.1 If the top and middle display lines are not within 5 mV check the following:

- Repeat the bucket calibration check (section 7.2). The electrode with the more positive reading is probably in error.
- Remove the reference electrode elements and replace with spares, being careful not to touch the silver/ silver chloride pellet with bare or greasy hands. Please see section 11.2 for details. Soak for 30 minutes with new elements.

13.1.2 If the tip wire is damaged, a temporary soft-splice repair can be made using ScotchKote® sealant (not included) and splicing tape. However, prolonged operation in this manner is not recommended. Order a new nose cone assembly as soon as possible.

13.1.3 After any replacement or repair, recalibrate the instrument by performing a bucket test as described in section 7.2.

If problem persists or is not listed, please call our hotline at +1 (713) 983-7117 and ask for Polatrak technical support.

Table 6: Troubleshooting quick guide

Symptom	Possible problem	Action
Instrument will not pass calibration tests (Section 7)	One electrode is bad	See section 11.2.
	Zinc coupon is passive (more positive than (-) 1.000V)	Remove zinc coupon and clean with file or sandpaper
	Readings more positive than (-) 1.000V	Inspect the tip wire for any damage.
	Electrodes are dry	Allow to soak for 30 minutes and retry
	Readings more negative than (-) 1.100V	Issue the Cal! command through the RS232 interface.
Both electrodes reading low	Tip wire damaged	Remove probe tail assembly, unplug tip wire, remove nose cone, inspect tip wire and repair with ScotchKote® as a temporary measure. Order replacement nose cone.
Readings are not steady and continue to change.	Poor structure contact	Re-stab to ensure contact.
One reading suddenly goes less negative	Connector is flooded.	Check connectors.
	Lead wire (flying lead) is nicked.	Inspect and repair / replace as necessary.
Displays are blank	Whip is cut or power polarity is inverted.	Check cabling and wiring.
Displays are too dim or blurry	Intensity is set too high or low for the available camera.	Increase intensity of light shining on meter. Adjust the intensity using the command line. See Table 5 - RS232 Command List
Garbled data stream output	Ground fault or improper shielding	Ensure RS232 signal ground and power ground are tied together subsea. Ensure RS232 signal ground is connected topside.
No data stream output	Broken wire in whip	Perform a loop-back test to verify communications. Visually inspect whip for damage.
	Incorrect port	Perform a loop-back test to verify communications.
	Swapped transmit / receive	Try swapping the transmit and receive wires on topside connection.
	Voltage on transmission line	Insert a null modem between ROV and computer

14. Spare parts and accessories

14.1 The Deep C Meter AD is shipped in a waterproof transit case and contains the following spares and accessories. Please contact your Deepwater representative to order additional spares if required.

14.1.1 Zinc calibration block.....(1)

14.1.2 Contact tips.....(3)

14.1.3 Lens retaining screws.....(4)

14.1.4 O-ring lube.....(1)

14.1.5 Silicone connector lube.....(1)

14.1.6 Bulkhead dummy plug.....(3)

14.1.7 Ag/AgCl electrode element.....(1)

14.1.8 Lens back-up ring.....(2)

14.1.9 Lens O-ring.....(4)

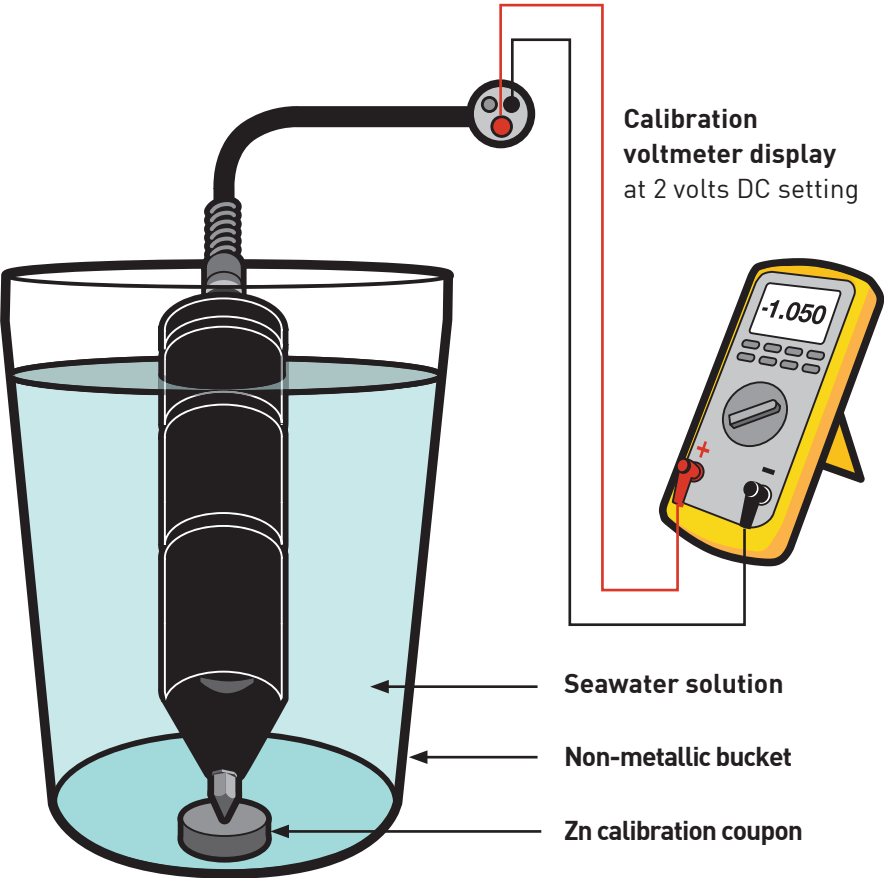
Table 7: List of spare parts

Part No.	Description	No. Required	No. Spares
DCM0019	Pressure housing	1	0
DCM0001	Articulating mount	1	0
MLT0052	Lens	1	0
GSK0009	Lens - O ring	2	4
GSK0008	Lens - backup ring	1	2
FAS0104	Lens retaining screw	4	1
MFR0015	Lens cover	1	0
UWC0038	Power bulkhead dummy plug (female)	1	0
UWC0046	EFG bulkhead dummy plug (male)	3	0
UWC0045	ROV II bulkhead dummy plug (female)	1	0
UWC0041	ROV II flying lead	1	0
UWC0049	Power cable whip	1	0
UWC0061	EFG flying lead	Optional	Optional
Call	EFG probe	Optional	Optional
DCM0008	ROV-II tail assembly	1	0
ROV0016	ROV II probe nose cone	1	0
ROV0004	Contact tip	1	3
MLT0045	Replaceable silver / silver chloride element	2	1
MLT0066	Readout	1	0
ROV0014	T-Handle for work-class ROV	1	0
GSK0006	Tube O-ring lubricant	1	0
EOR0015	Tube connector sealant	1	0
ROV0018	Zinc calibration block	1	0
358-MN03-ENG	Instruction manual	1	0
MFR0059	Protective case	1	0
MFR0005	Protective case O-ring	3	0
Call	Protective case foam pack	1	0

Figure 7

CELL TO ZN COUPON

ROV-II™ CALIBRATION WIRING SCHEMATIC



Step	+VE	-VE	DC scale	Expected result
01	Tip / Pin 1	Reference electrode 2 / Pin 3	2 V	-1.030 to -1.070
02	Tip / Pin 1	Reference electrode 1 / Pin 2	2 V	-1.030 to -1.070

Note: Clean the Zn coupon with a file or sandpaper before using.

(Readings should be within 0.005V of each other)

This image shows a full page of white paper with horizontal dashed lines, typical of primary-ruled notebook paper. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.